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Coastal Time Series (CTS): A Database of Coastal Temperature Time Series for the Canadian East Coast

Séries Chronologiques Côtières (CTS) : Base de données sur les séries chronologiques de la température de la côte est du Canada

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ABSTRACT

Time series of temperature from coastal and freshwater locations have been collected extensively in Newfoundland and Labrador since 1967 and the Scotian Shelf, Bay of Fundy, Gulf of Maine, Gulf of St. Lawrence and St. Lawrence Estuary since 1978 using moored sensors. Major contributors to the dataset include the Department of Fisheries and Oceans in the Maritimes, Newfoundland and Labrador, Gulf and Québec regions, supplemented by provincial and partnership agencies. The Coastal Time Series Database (CTS) is a compilation of these data and is maintained as a web accessible database by the Ocean Science Division at the Bedford Institute of Oceanography. The address is:
http://www.mar.dfo-mpo.gc.ca/science/ocean/database/data_query.html.

RÉSUMÉ

Des instruments installés en eau marine et en eau douce recueillent des données sur la température depuis 1967 pour la côte de Terre-Neuve-et-Labrador et depuis 1978 pour le plateau néo-écossais, la baie de Fundy, le golfe du Maine, le golfe Saint-Laurent et l'estuaire du Saint-Laurent. Il s'agit d'un vaste ensemble de données auquel ont notamment contribué le ministère des Pêches et des Océans (régions des Maritimes, de Terre-Neuve-et-Labrador, du Golfe et du Québec) ainsi que des organismes provinciaux et d'autres partenaires. La base de données sur les séries chronologiques côtières (CTS) rassemble ces données et les rend accessibles par le truchement du site Web de la Division des sciences océanologiques de l'Institut océanographique de Bedford. En voici l'adresse :
http://www.mar.dfo-mpo.gc.ca/science/ocean/database/data_query_f.html.

INTRODUCTION

Temperature data from coastal areas have been collected extensively in Newfoundland and Labrador since 1967 and the Scotian Shelf, Bay of Fundy, Gulf of Maine, Gulf of St. Lawrence and St. Lawrence Estuary since 1978. The program, referred to as the Long-Term Temperature Monitoring Program (LTTMP) in Maritimes[1] and Newfoundland and Labrador and the Thermograph Network[2] in Québec Region, is conducted mainly to support various fisheries programs and to monitor long-term temperature changes near the coast in support of the Atlantic Zone Monitoring Program. The major contributors to the dataset are programs conducted by Fisheries and Oceans in Maritimes, Newfoundland and Labrador, Gulf and Québec regions. These are supplemented by provincial agencies and partnerships such as the Fisherman and Scientists Research Society. The Coastal Time Series Database (CTS) is a compilation of these data and is maintained as a web accessible database by the Ocean Science Division at the Bedford Institute of Oceanography. The web address is:
http://www.mar.dfo-mpo.gc.ca/science/ocean/database/data_query.html[1].

SOURCE DATA

As of October 2004, the data archive includes about 4400 coastal temperature time series from inshore areas on the Scotian Shelf, Bay of Fundy, Gulf of Maine, Gulf of St. Lawrence, the St. Lawrence Estuary and the Newfoundland and Labrador coasts (Figure 1). A significant number of these series (20%) are from freshwater sites, primarily in Newfoundland and Prince Edward Island. Over 90% of the marine series are moored at depths of 30m or less. About 125 new series are added annually.

All of the data in database are held at the Bedford Institute of Oceanography (BIO). A substantial amount of the data originated with (and are archived by) other organizations. In addition to research programs from various groups at the Bedford Institute, data are regularly obtained from St. Andrews Biological Station (SABS), Institut Maurice-Lamontagne (IML), MontJoli, P.Q[2]., Northwest Atlantic Fisheries Center (NAFC), St. John's, Nfld,[3] Gulf Fisheries Center (GFC), Moncton, N.B. and provincial agencies. Calibrations of the instruments and processing of the data are carried out by the originating laboratories at NAFC, BIO and IML.

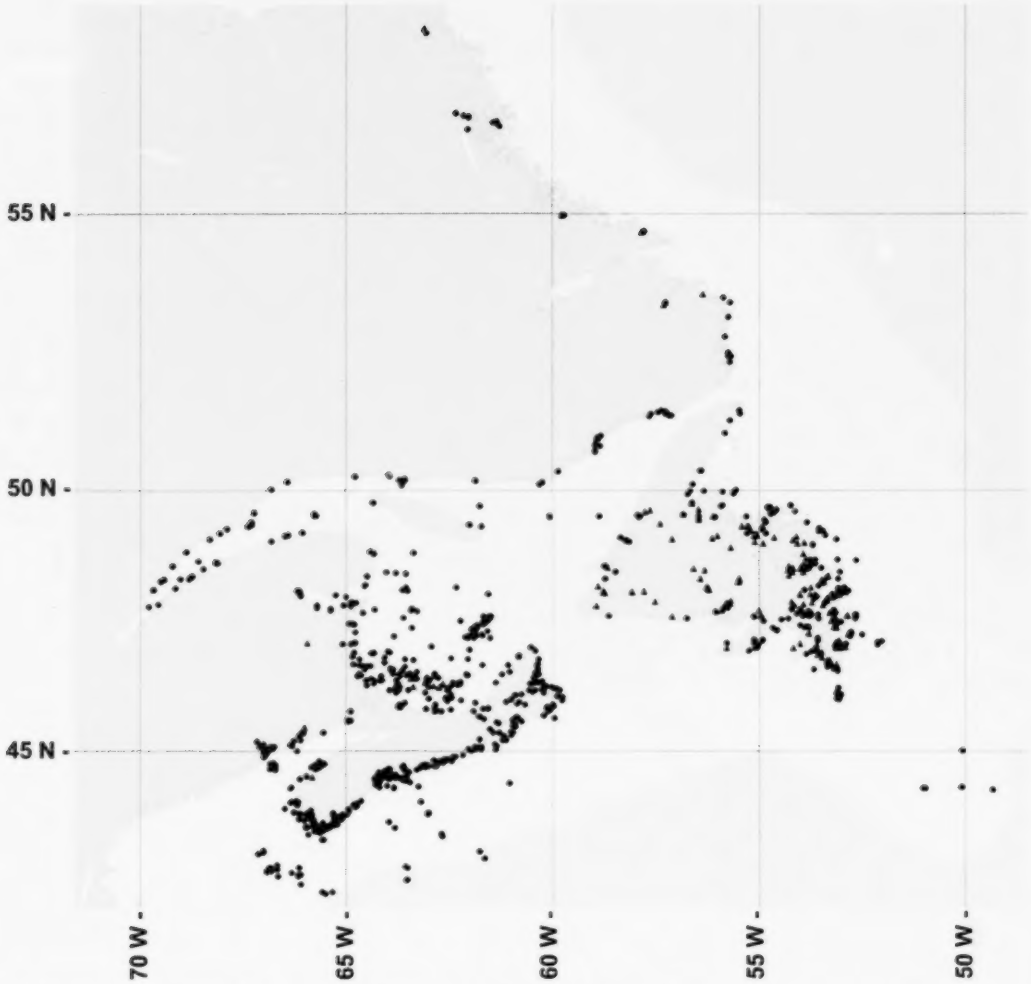

Figure 1 Moored Thermographs in the CTS Database Circles are saltwater stations. Triangles are fresh water locations.

INSTRUMENTATION

From 1967 until 1990 the primary instrument was an analogue thermograph which recorded data on paper strip charts and was manually digitized at a four-hour interval. Digital recording thermographs were introduced in the mid 1980s, and over the course of the program a variety of instruments from different manufacturers have been used. Sampling intervals of the digital instruments are typically 30 minutes to one hour. The last mechanical instrument was used in 1992. The accuracy of the mechanical instrument was about 0.5°C. The manufacturers of the digital instruments claim accuracies of 0.1°C.

DATA DISTRIBUTION

The early records in the database are all from Newfoundland and Labrador region and are typically 1 month long. With the beginning of the LTTMP in 1978, the number of deployments increased dramatically, peaking in the late 1980s (Figure 2). Typical mooring duration increased to 3-4 months. With the development of low cost digital thermographs, the number of deployments is again on the rise and average deployment times are up to 5 months.

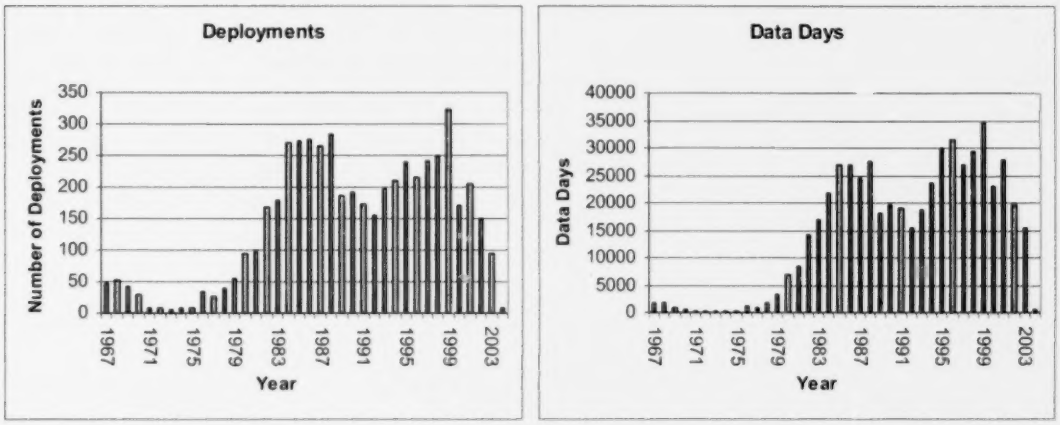

Figure 2 Thermograph Deployments and Data Days / Year

Deployments are fairly evenly distributed within the Scotian Shelf, Bay of Fundy, Gulf of St. Lawrence, St. Lawrence Estuary and Newfoundland and Labrador Shelf geographic regions (Figure 3).

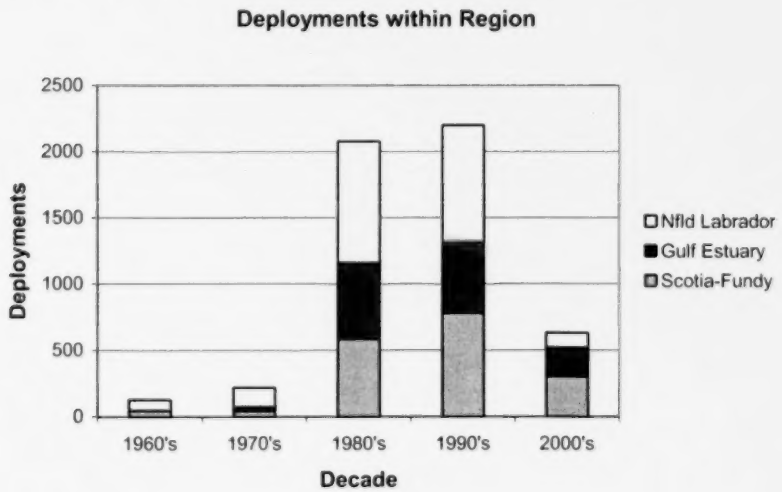

Figure 3 Distribution of Deployments by Geographical Region

DATABASE CONTENTS

The database consists of daily average temperatures generated from the original source observations. The minimum, maximum, standard deviation and count of original observations are included with each daily average. Metadata associated with the statistics include geographic position, start and end date and time, sampling depth, original sampling interval, instrument manufacturer and serial number.

DATA VALIDATION

All of the data are initially quality controlled by the originating source. The quality flags in the database are determined solely by the daily statistics. The statistics are subjected to a series of tests and assigned quality flags as described below.

Quality	Description
1	Did not fail any of the tests
2	Extremes greater than 4 standard deviations from the daily mean (spiking).
3	Constant value (minimum value = maximum value)
4	Extremes out of range (minimum < -2.5°C or maximum > 30°C)
5	Mean out of range (average < -2.5°C or > 30°C)

Time series that have any test failure are re-examined and edited if possible (usually involving de-spiking of the data by a median filter or by linear interpolation). Any statistics that had a quality of 4 or greater are rejected. Statistics that had a quality of 2 but no obvious spiking outside of the background variability are retained. Statistics with a constant value (quality = 3) are also retained as not unreasonable because of the low accuracy (~ 0.5°C) and relatively short (24 hour) averaging period of the earlier instruments.

DATA ACCESS

Data in the Coastal Time Series database are freely available to anyone. Up-to-date details and access to the database can be found at the Ocean Science web site[1] http://www.mar.dfo-mpo.gc.ca/science/ocean/database/data_query.html.

Because the query application is constantly undergoing enhancements in response to user requests, a detailed description of the application is not provided. Some of the features include the following:

The use of CTS requires a one-time registration. Registration permits access to CTS and other Ocean Science databases. Additional databases consist of:

- Climate[4] - a collection of temperature and salinity profile data for the Northwest Atlantic and Eastern Arctic
- Ocean Data Inventory[5] (ODI) - monthly current, temperature and salinity statistics for all time series measurements in the BIO archive
- Sea Surface Temperature (SST) - weekly composite sea-surface temperature observations from NOAA satellite

A description of all the databases available is also described at the Ocean Science web site[1] http://www.mar.dfo-mpo.gc.ca/science/ocean/database/data_query.html.

Users can specify spatial and temporal criteria with latitude/longitude ranges, user or system defined polygons, multiple depth ranges, and time windowing options. Queries are saved and can be edited and re-run at any time.

A query provides a number of products which are generated on demand from the daily averages including a simple extraction of the individual daily statistics, a spatially averaged daily time series, a monthly time series, and an annual cycle. The spatially averaged daily time series is obtained by grouping all the series within the user specified rectangle or polygon. Values are averaged where series overlap in time. The monthly time series is obtained from the spatially averaged daily series. The annual cycle is in turn based on the monthly averages. Products can be viewed as either time series plots or in tabular form. Tables can be readily saved as a spreadsheet for further analysis on the user's computer.

Complete time series data can be made available on request. Each time series is associated with an event specification (event_spec) that uniquely identifies the series. Original data series can be obtained by emailing the author and including a list of the event_specs required. The climatological annual cycle is also available as a data product for a number of the statistical subdivisions defined by the Northwest Atlantic Fisheries Organization (NAFO). See http://www.mar.dfo-mpo.gc.ca/science/ocean/coastal_temperature/coastal_temperature.html[6]

ACKNOWLEDGMENTS

A multi-region data compilation such as CTS requires the cooperation and coordination of a number of individuals. Eugene Colbourne and Dave Senciall in the Newfoundland and Labrador region, Randy Losier at St. Andrews, Rick Boyce in the Maritimes region, and Bernard Pettigrew and Bernard Pelchat in the Québec region all provide support to regional temperature monitoring programs and continue to provide data for this compilation. Karen Atkinson does the final processing, quality control and updates to the CTS database. The database

application was developed and continues to be improved by Science Informatics at BIO.

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